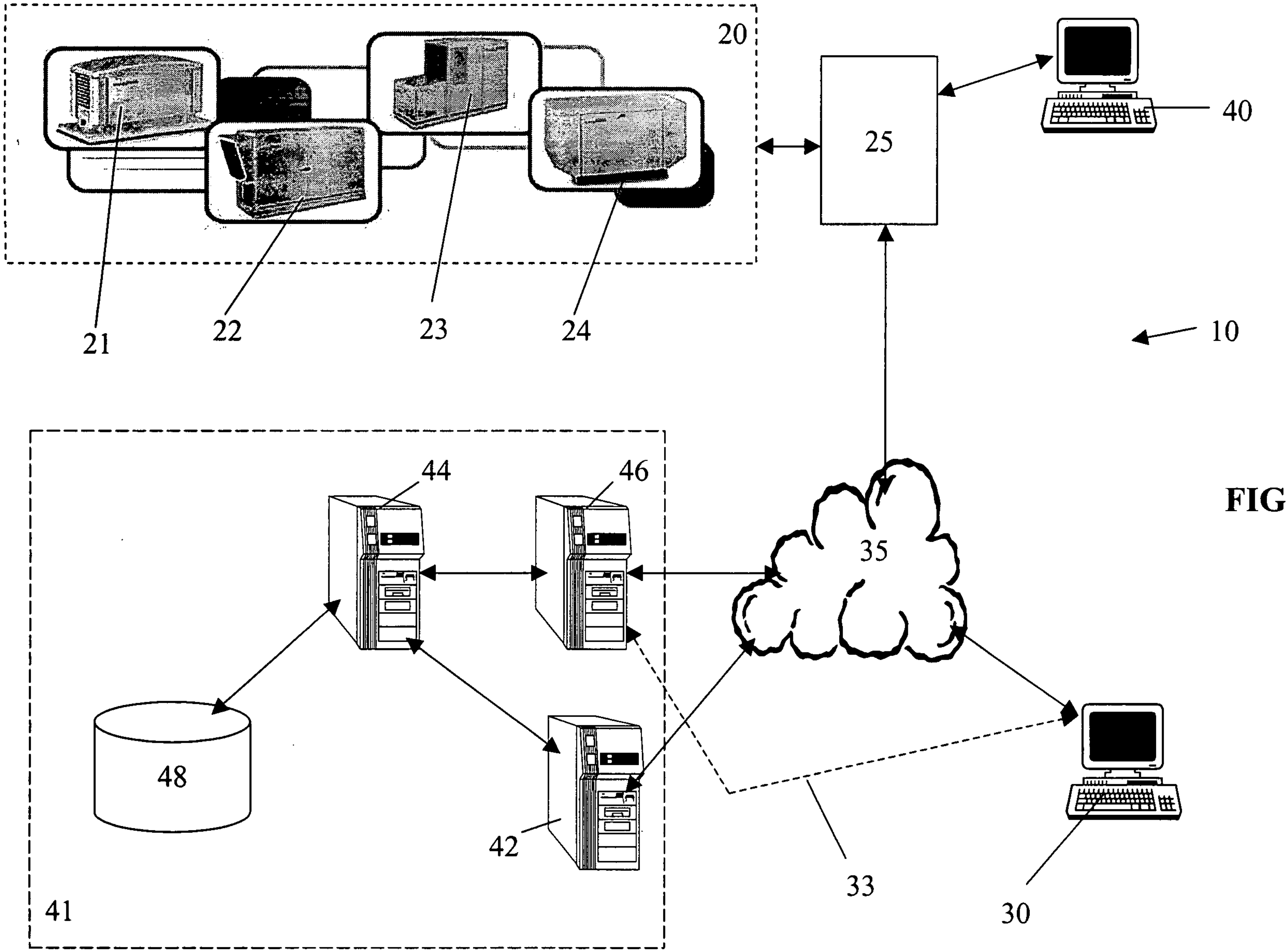


FIG. 1

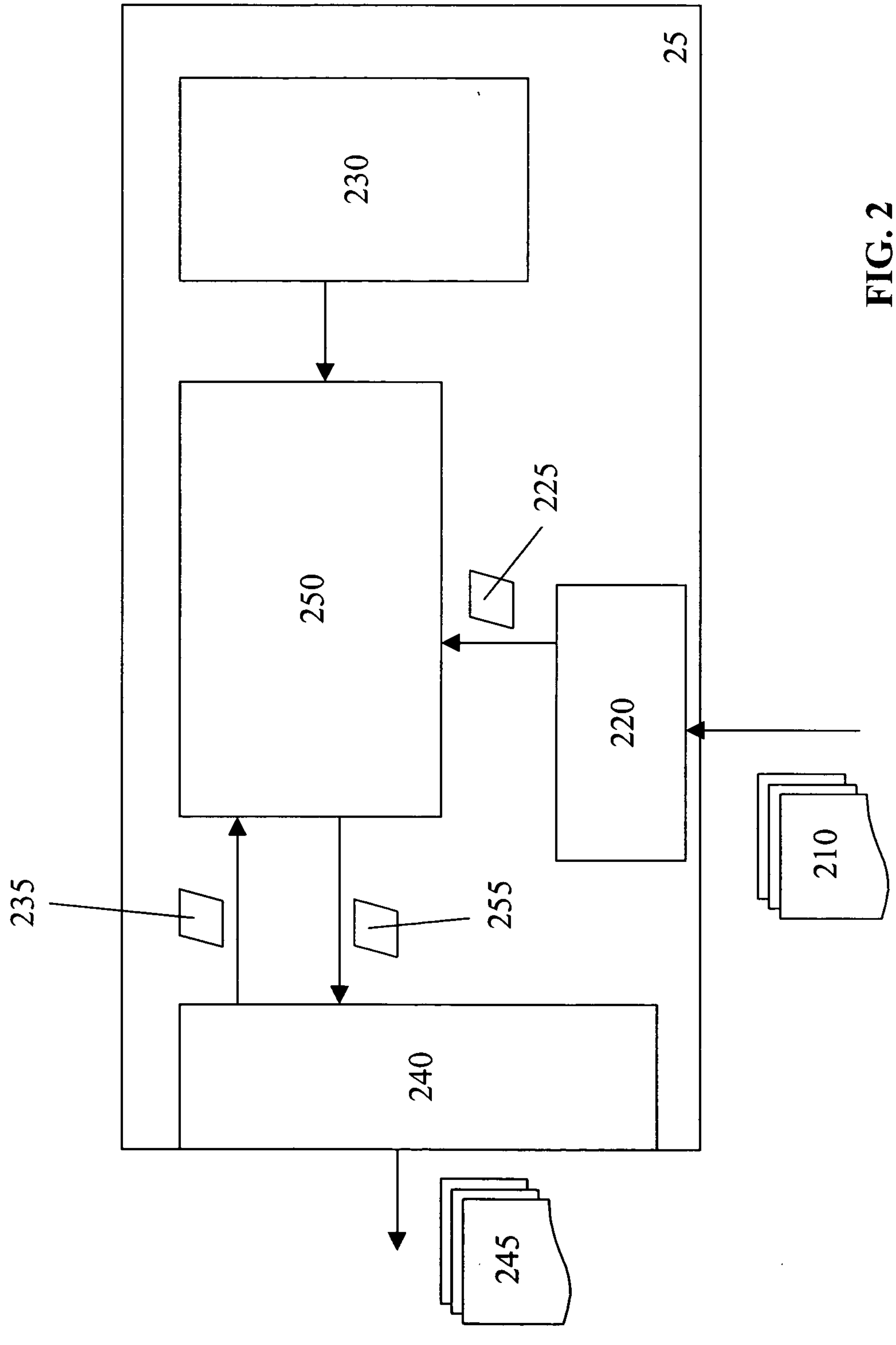


FIG. 2

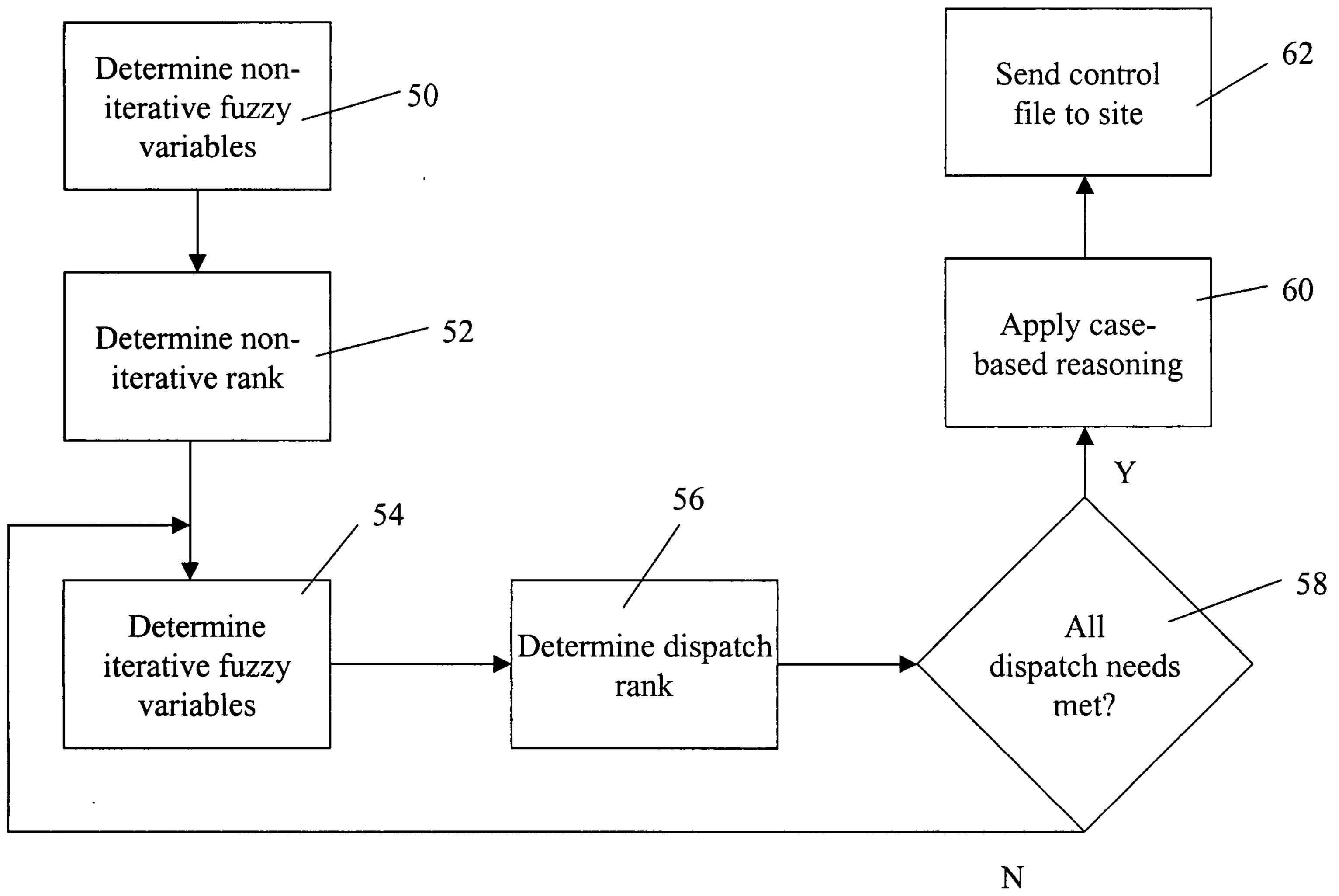

Determine non-iterative fuzzy variables
50
Determine non-iterative rank
52
Determine iterative fuzzy variables
54
Determine dispatch rank
56
All dispatch needs met?
58
Y
N
Apply case-based reasoning
60
Send control file to site
62

FIG. 3

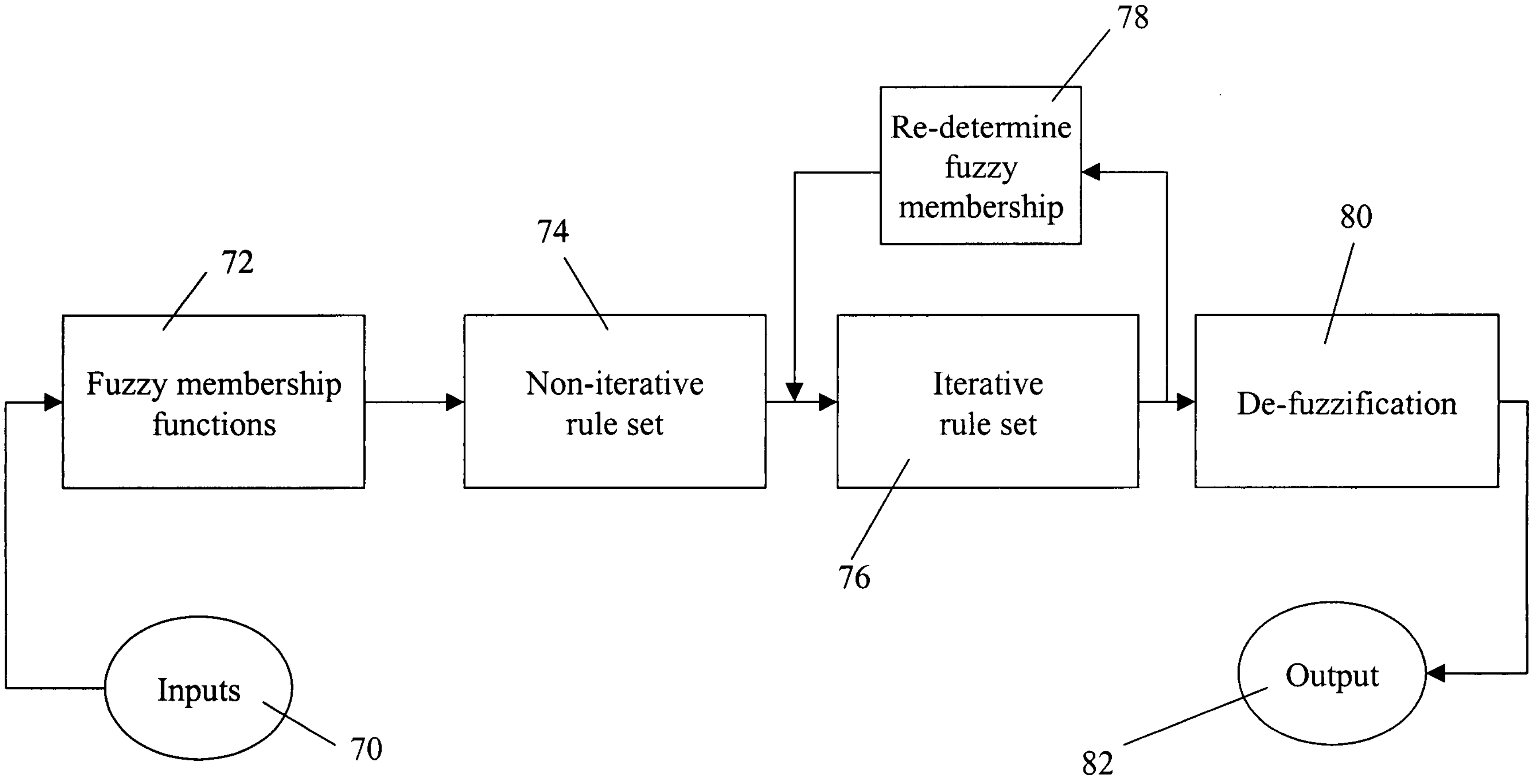

78
Re-determine fuzzy membership
74
72
80
Fuzzy membership functions
Non-iterative rule set
Iterative rule set
De-fuzzification
76
Inputs
70
Output
82

FIG. 4

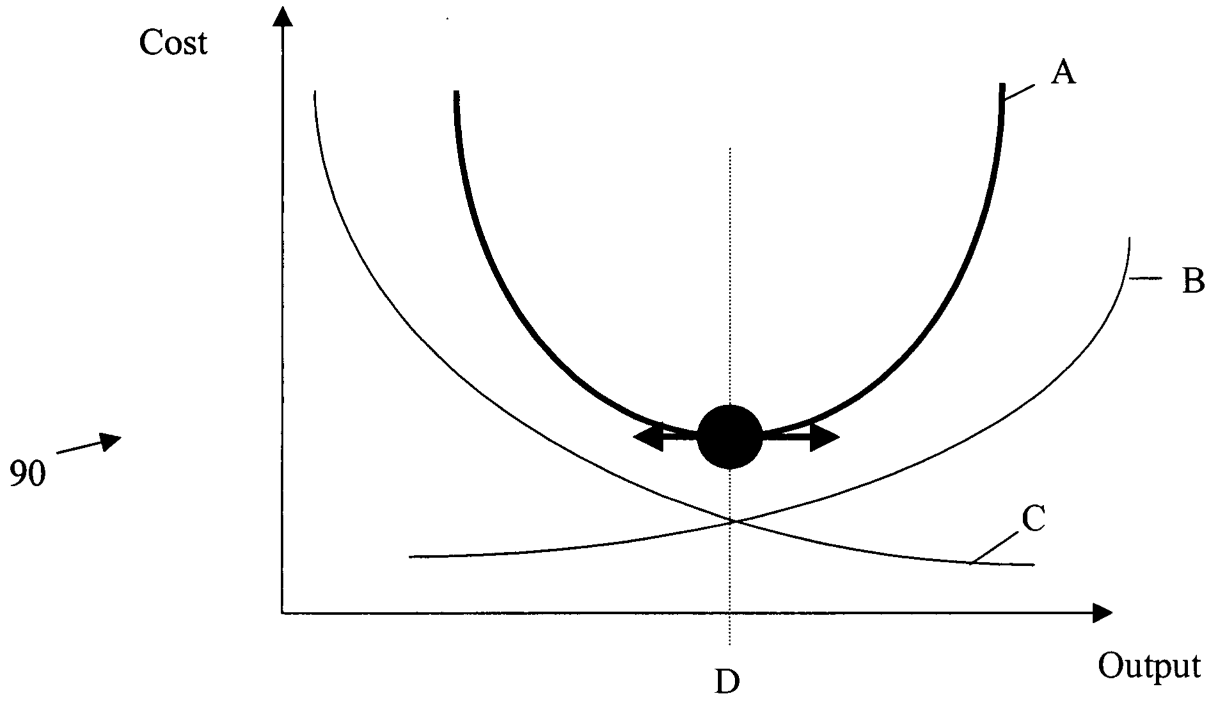
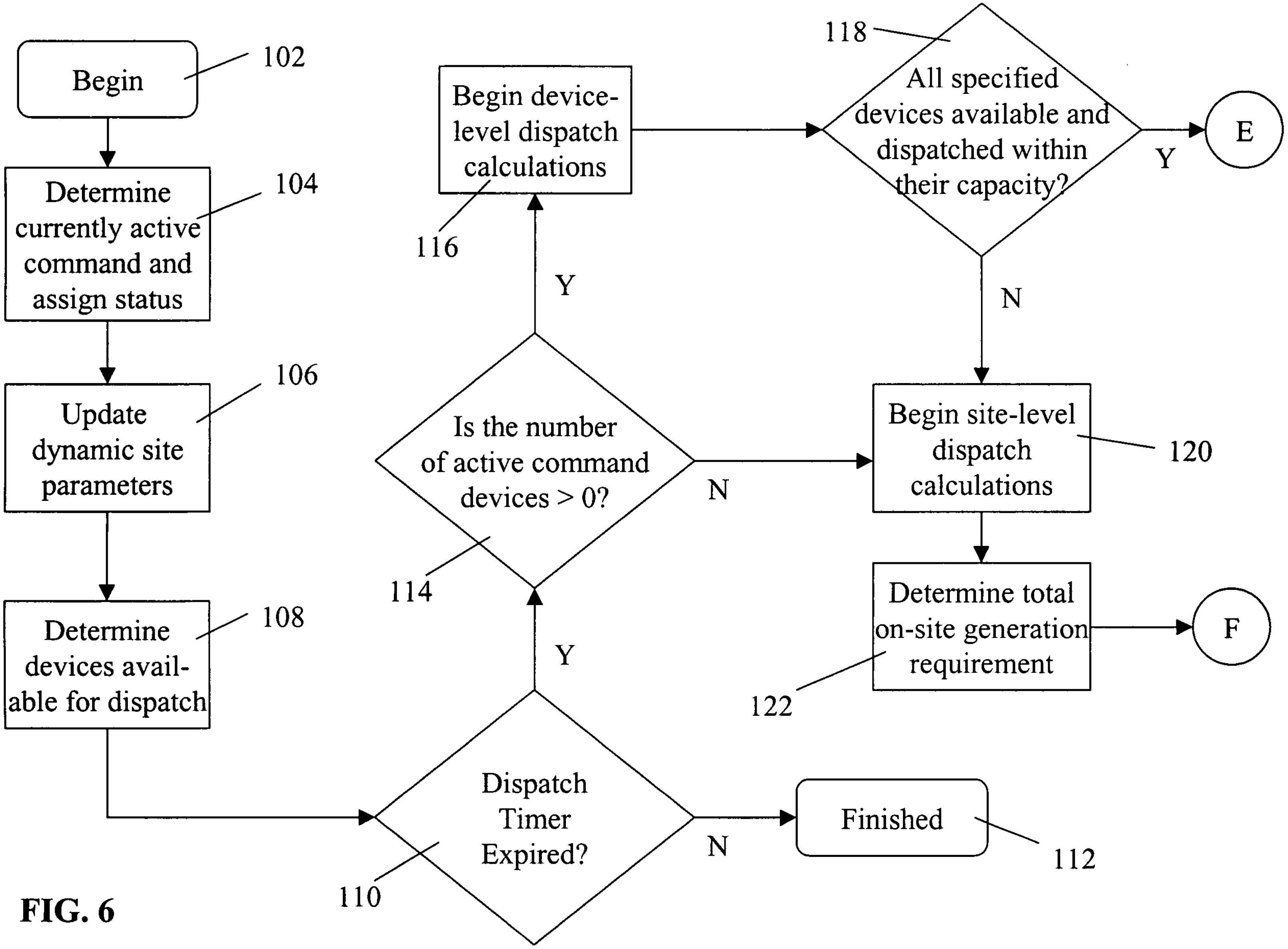


FIG. 5



Begin
102
Determine currently active command and assign status
104
Update dynamic site parameters
106
Determine devices available for dispatch
108
Dispatch Timer Expired?
110
Y
N
Finished
112
Is the number of active command devices > 0?
114
Y
N
Begin device-level dispatch calculations
116
All specified devices available and dispatched within their capacity?
118
Y
E
N
Begin site-level dispatch calculations
120
Determine total on-site generation requirement
122
F

FIG. 6

**FIG. 7**

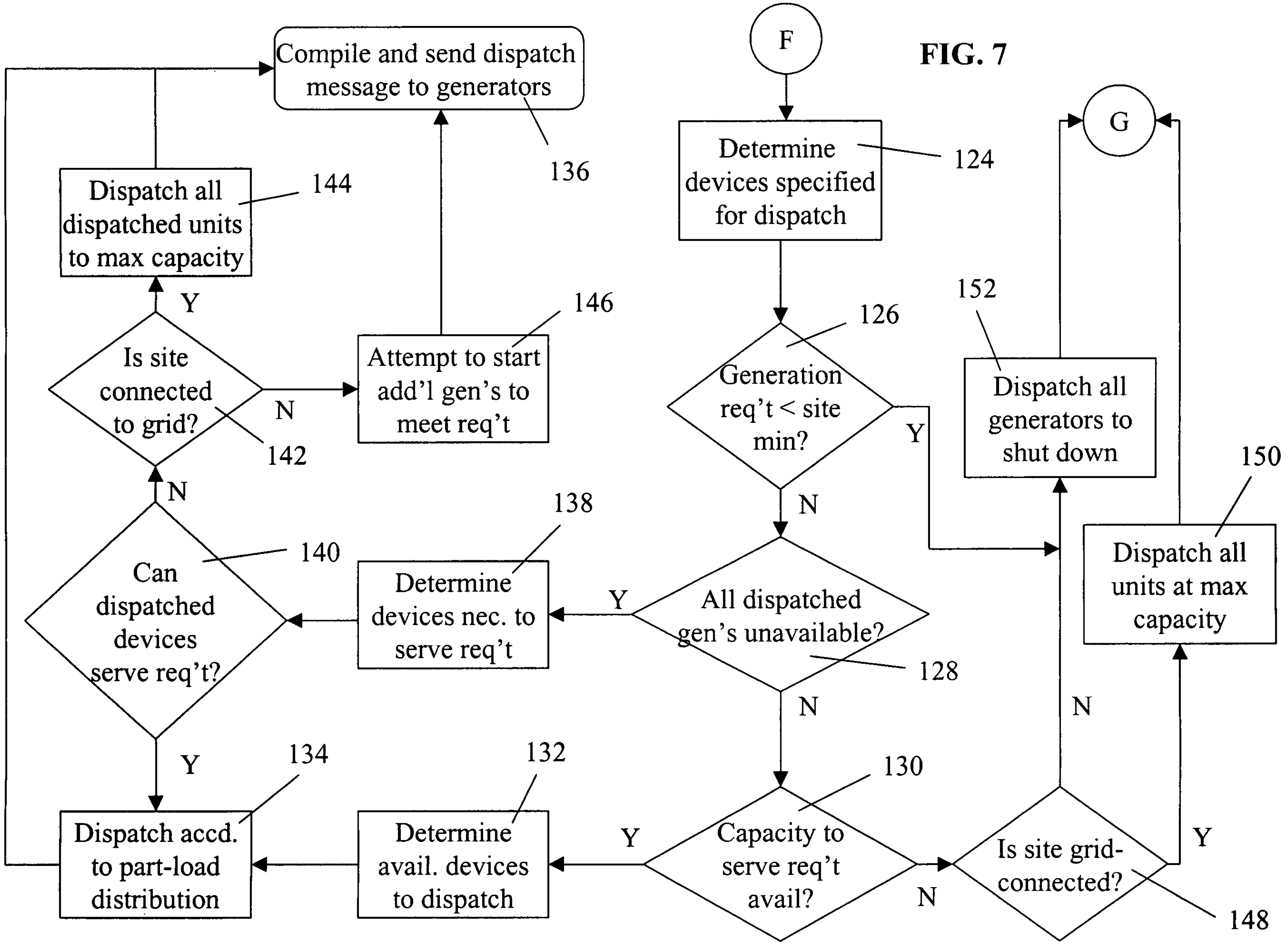
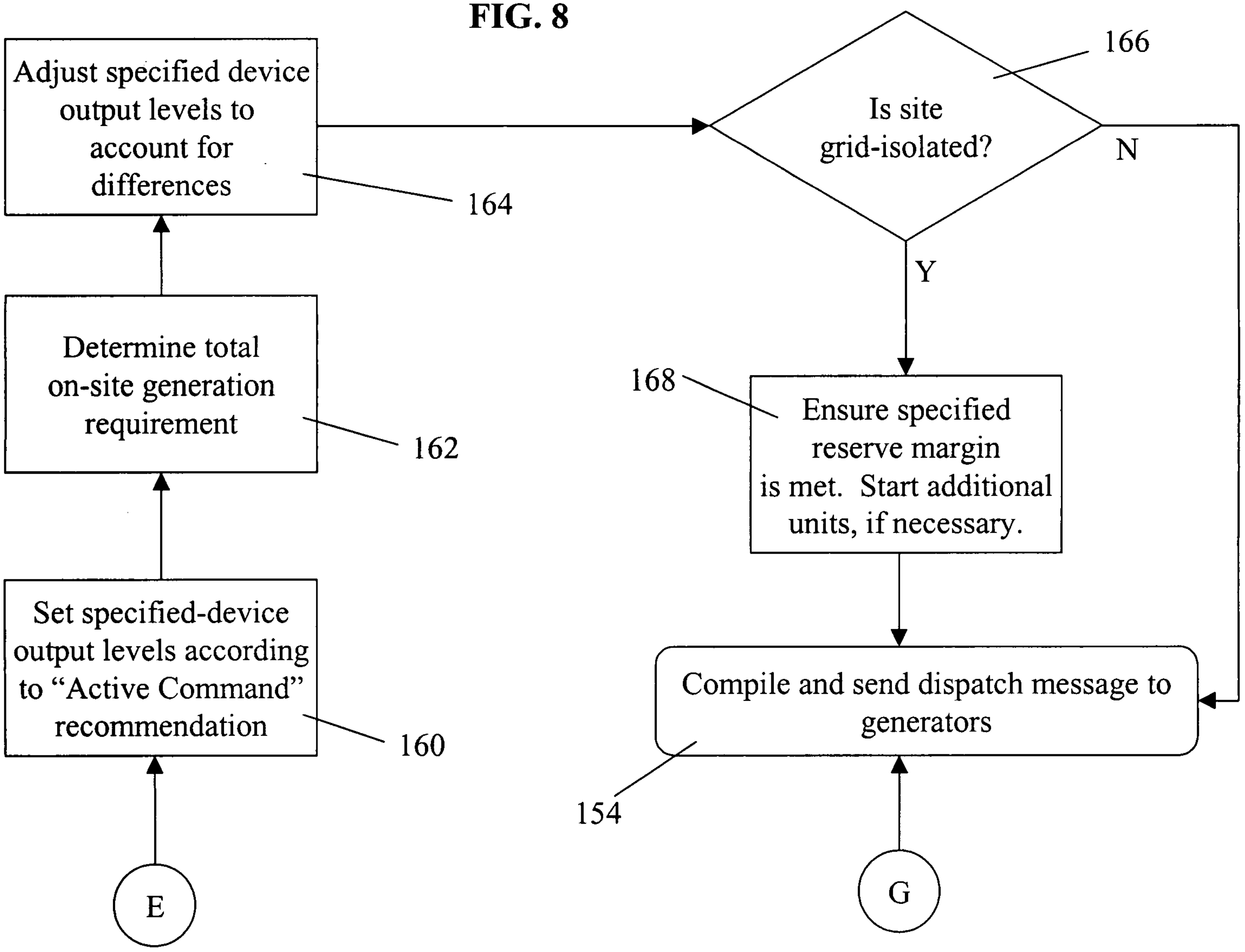

F
Determine devices specified for dispatch
124
Generation req't < site min?
126
Y
N
All dispatched gen's unavailable?
128
Y
N
Capacity to serve req't avail?
130
Y
N
Determine avail. devices to dispatch
132
Dispatch accd. to part-load distribution
134
Compile and send dispatch message to generators
136
Determine devices nec. to serve req't
138
Can dispatched devices serve req't?
140
Y
N
Is site connected to grid?
142
Y
N
Dispatch all dispatched units to max capacity
144
Attempt to start add'l gen's to meet req't
146
Is site grid-connected?
148
Y
N
Dispatch all units at max capacity
150
Dispatch all generators to shut down
152
G

FIG. 8


Adjust specified device output levels to account for differences
164
Is site grid-isolated?
166
N
Y
Determine total on-site generation requirement
162
168
Ensure specified reserve margin is met. Start additional units, if necessary.
Set specified-device output levels according to "Active Command" recommendation
160
Compile and send dispatch message to generators
154
E
G

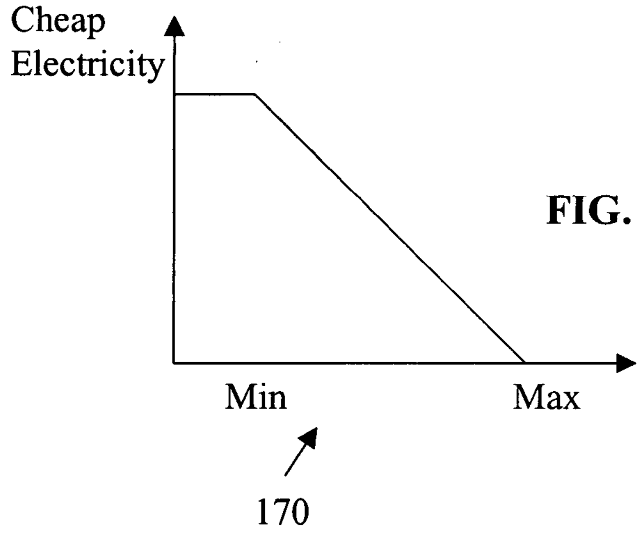


FIG. 9A

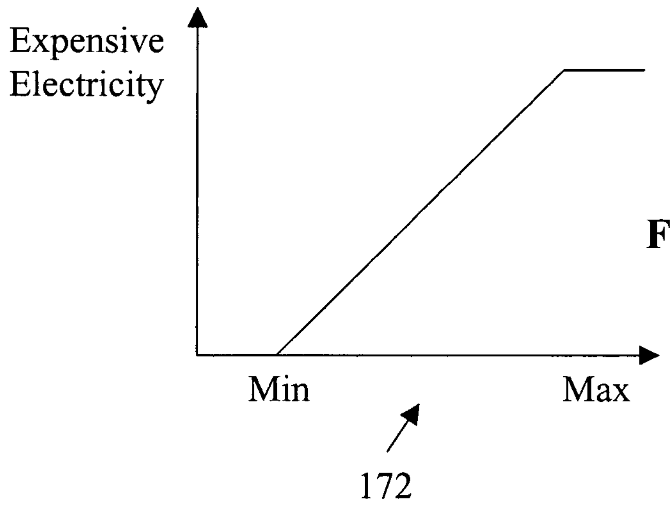


FIG. 9B

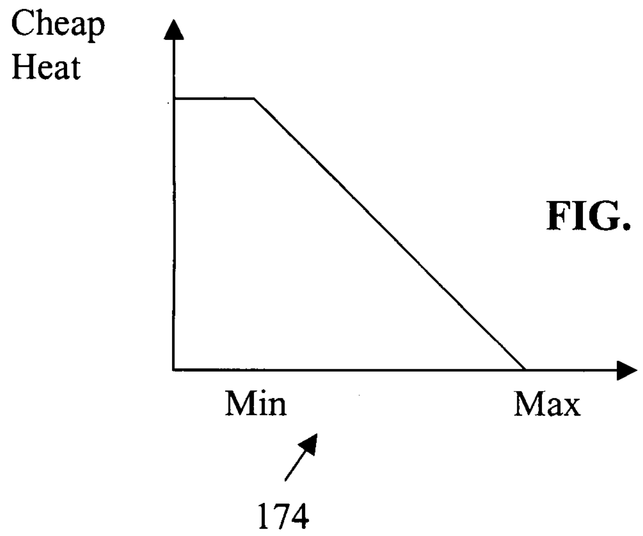


FIG. 10A

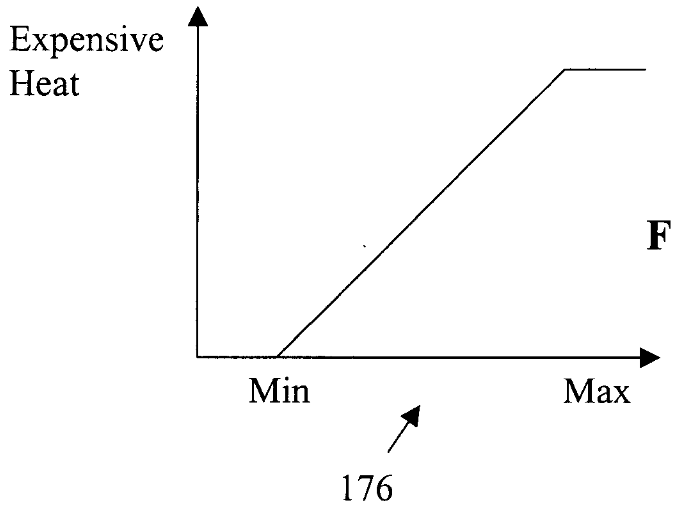


FIG. 10B

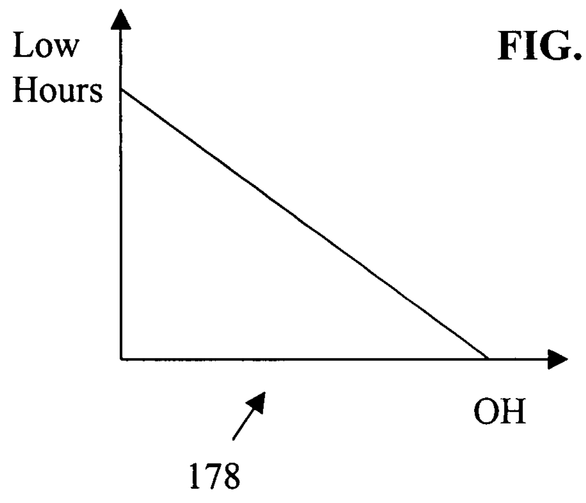


**FIG. 11A**

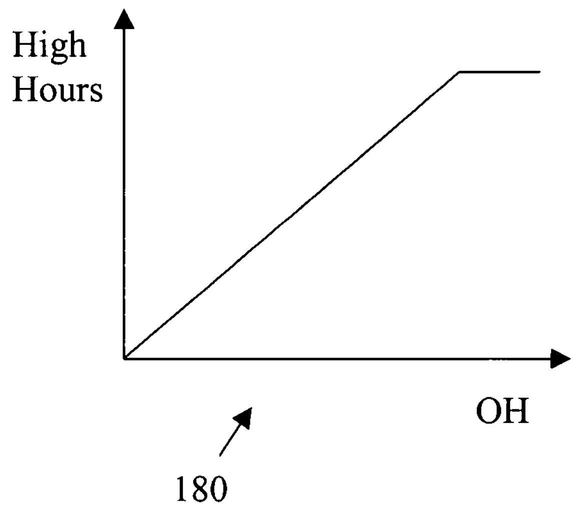


**FIG. 11B**

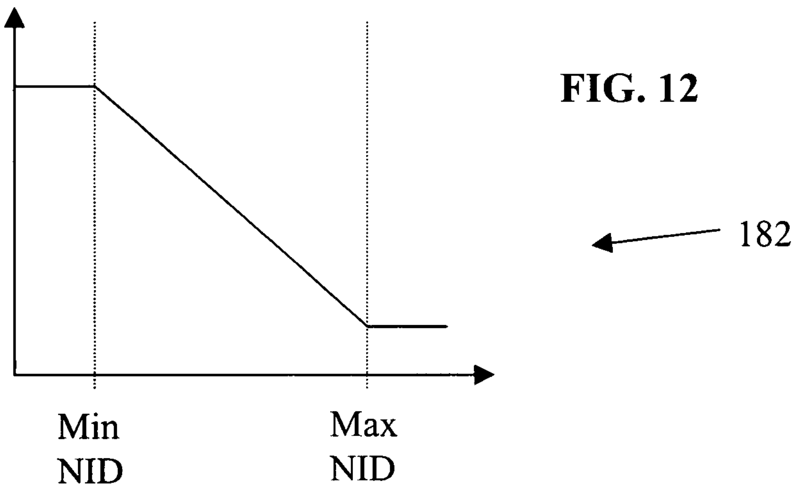


**FIG. 12**

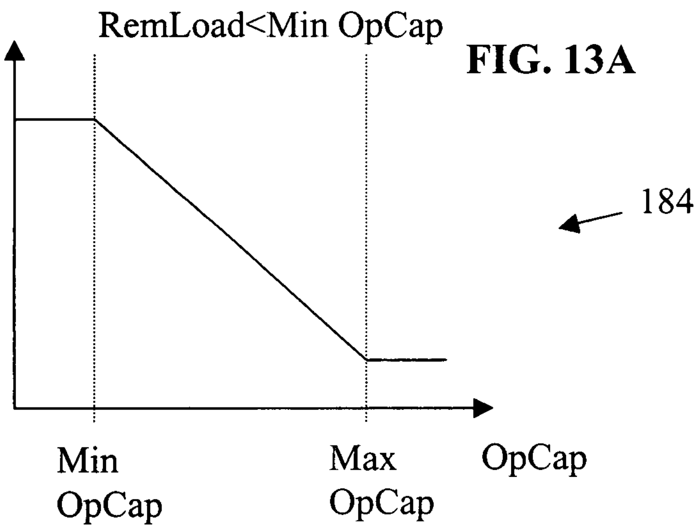


FIG. 13A

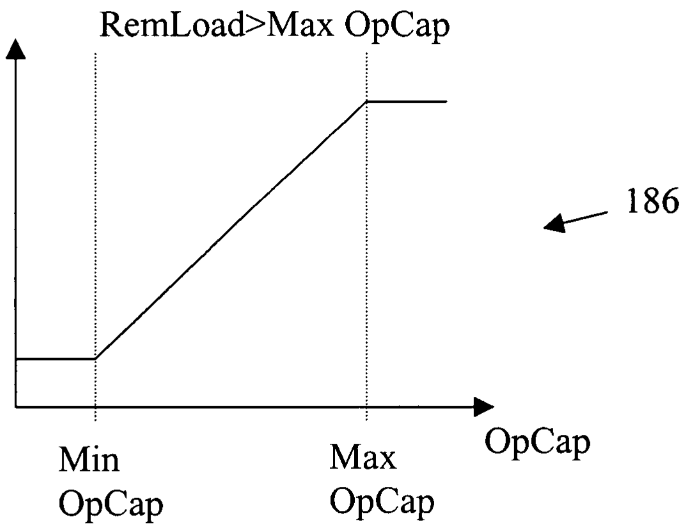


FIG. 13B

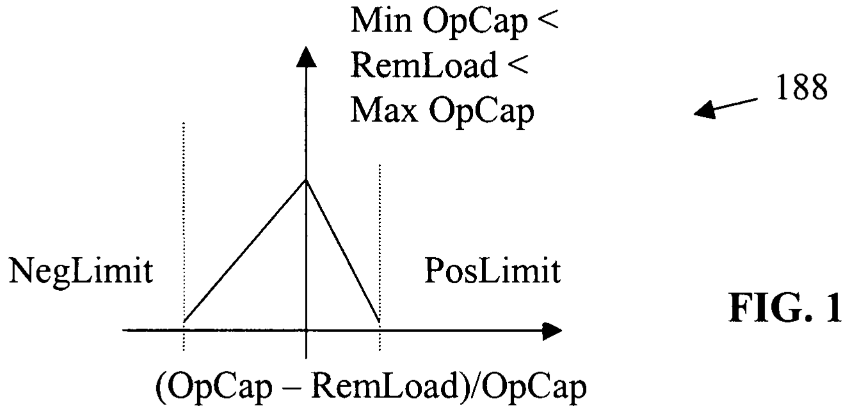


FIG. 13C

FIG. 14

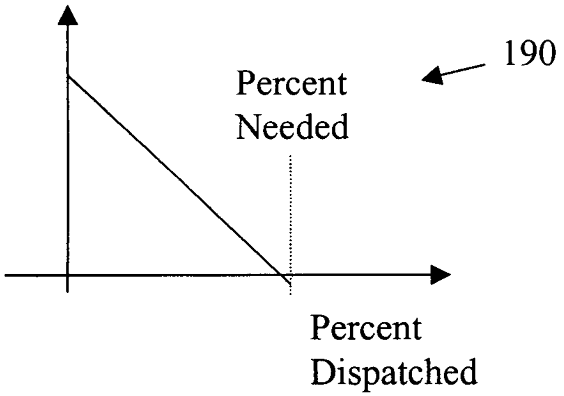
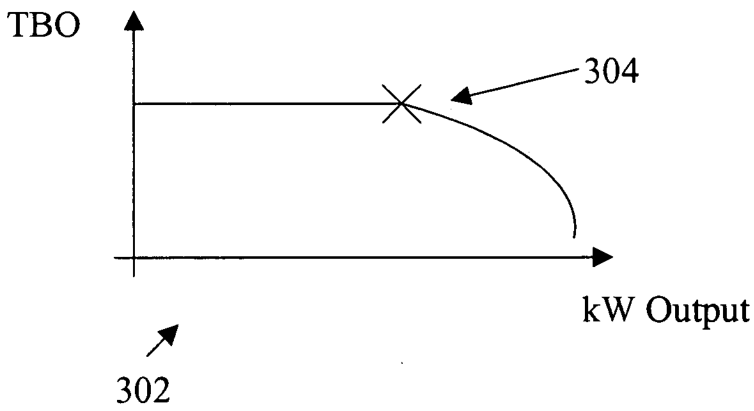


FIG. 16



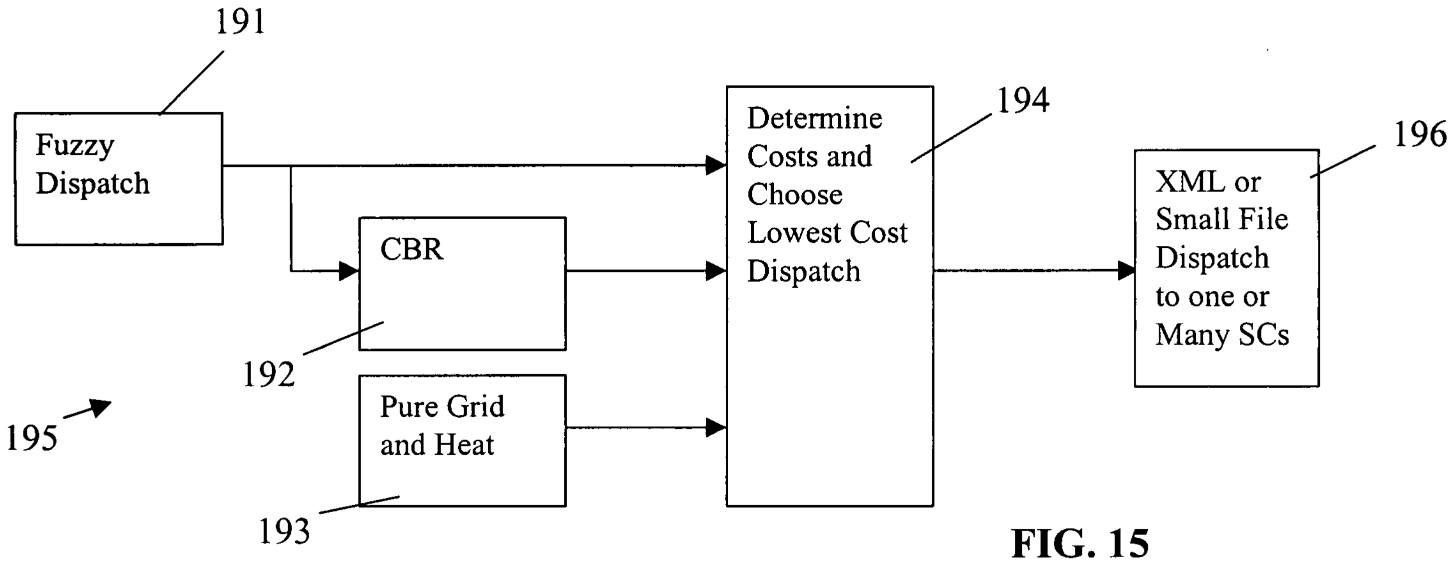


FIG. 15

FIG. 17A

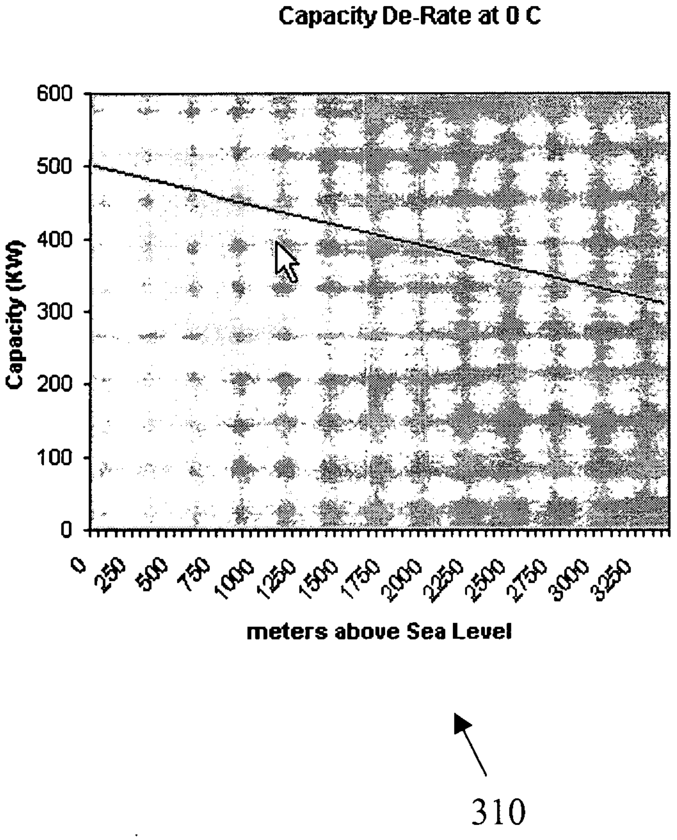
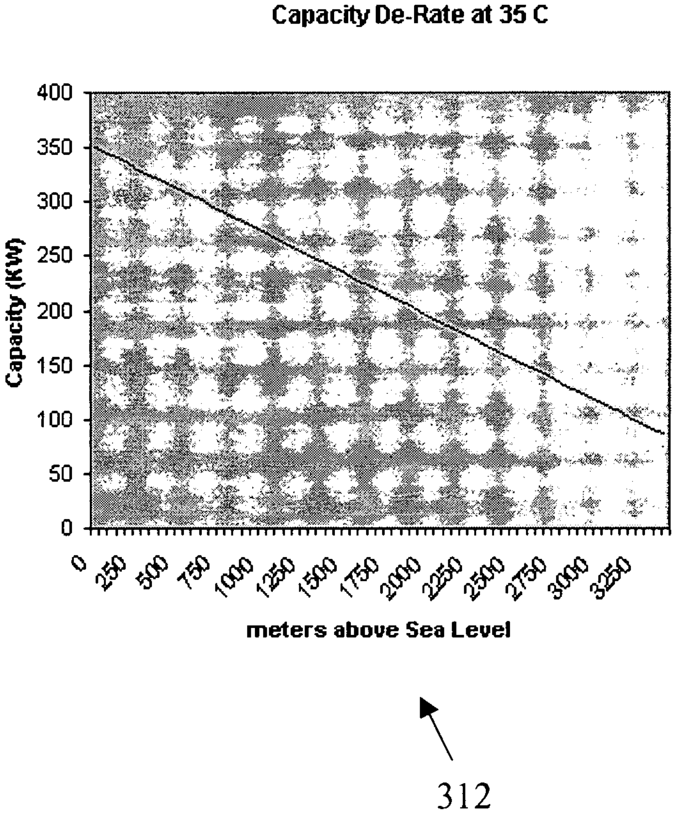
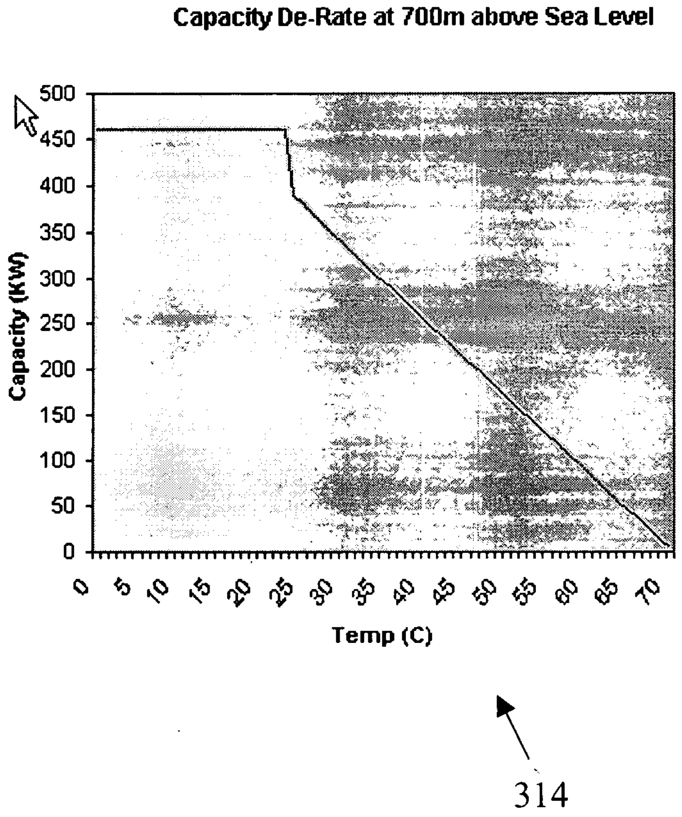


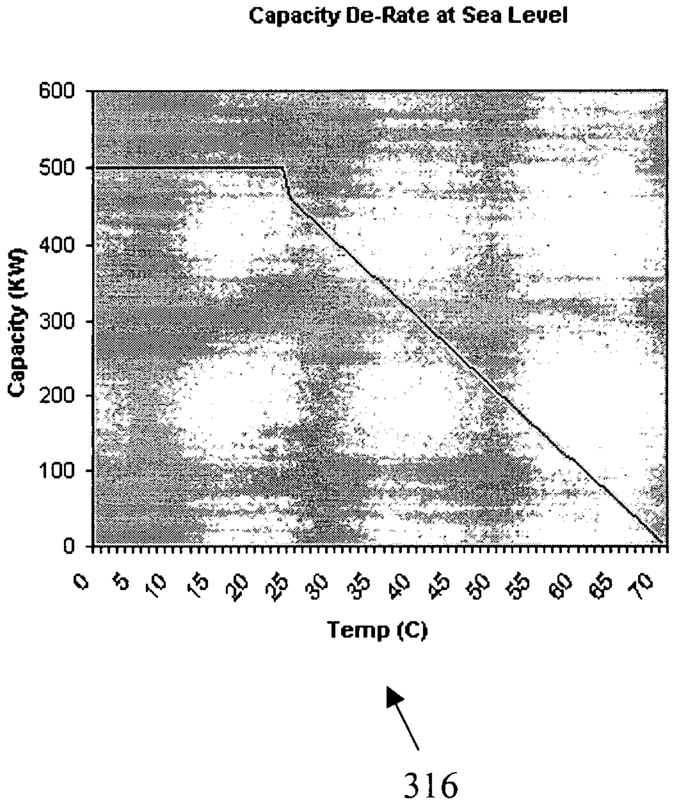
FIG. 17B

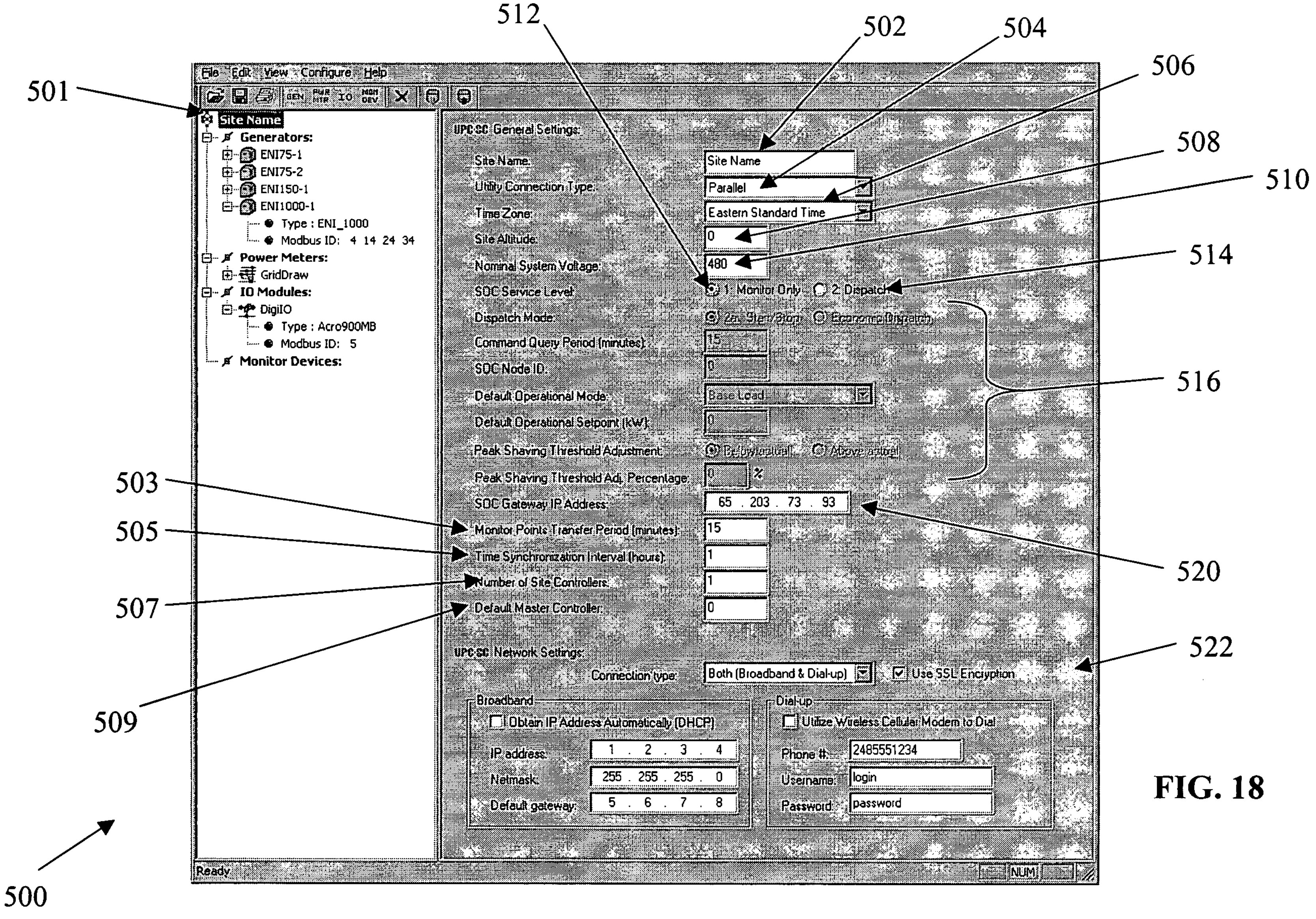


## FIG. 17C



## FIG. 17D





UPC-SC General Settings:

Site Name: Site Name

Utility Connection Type: Parallel

Time Zone: Eastern Standard Time

Site Altitude: 0

Nominal System Voltage: 480

SOC Service Level: ● 1: Monitor Only ○ 2: Dispatch

Dispatch Mode: ● Zn. Start/Stop ○ Economic Dispatch

Command Query Period (minutes): 15

SOC Node ID: 0

Default Operational Mode: Base Load

Default Operational Setpoint (kW): 0

Peak Shaving Threshold Adjustment: ● Below actual ○ Above actual

Peak Shaving Threshold Adj. Percentage: 0 %

SOC Gateway IP Address: 65 . 203 . 73 . 93

Monitor Points Transfer Period (minutes): 15

Time Synchronization Interval (hours): 1

Number of Site Controllers: 1

Default Master Controller: 0

UPC-SC Network Settings:

Connection type: Both (Broadband & Dial-up) ☑ Use SSL Encryption

Broadband

☐ Obtain IP Address Automatically (DHCP)

IP address: 1 . 2 . 3 . 4

Netmask: 255 . 255 . 255 . 0

Default gateway: 5 . 6 . 7 . 8

Dial-up

☐ Utilize Wireless Cellular Modem to Dial

Phone #: 2485551234

Username: login

Password: password

FIG. 18

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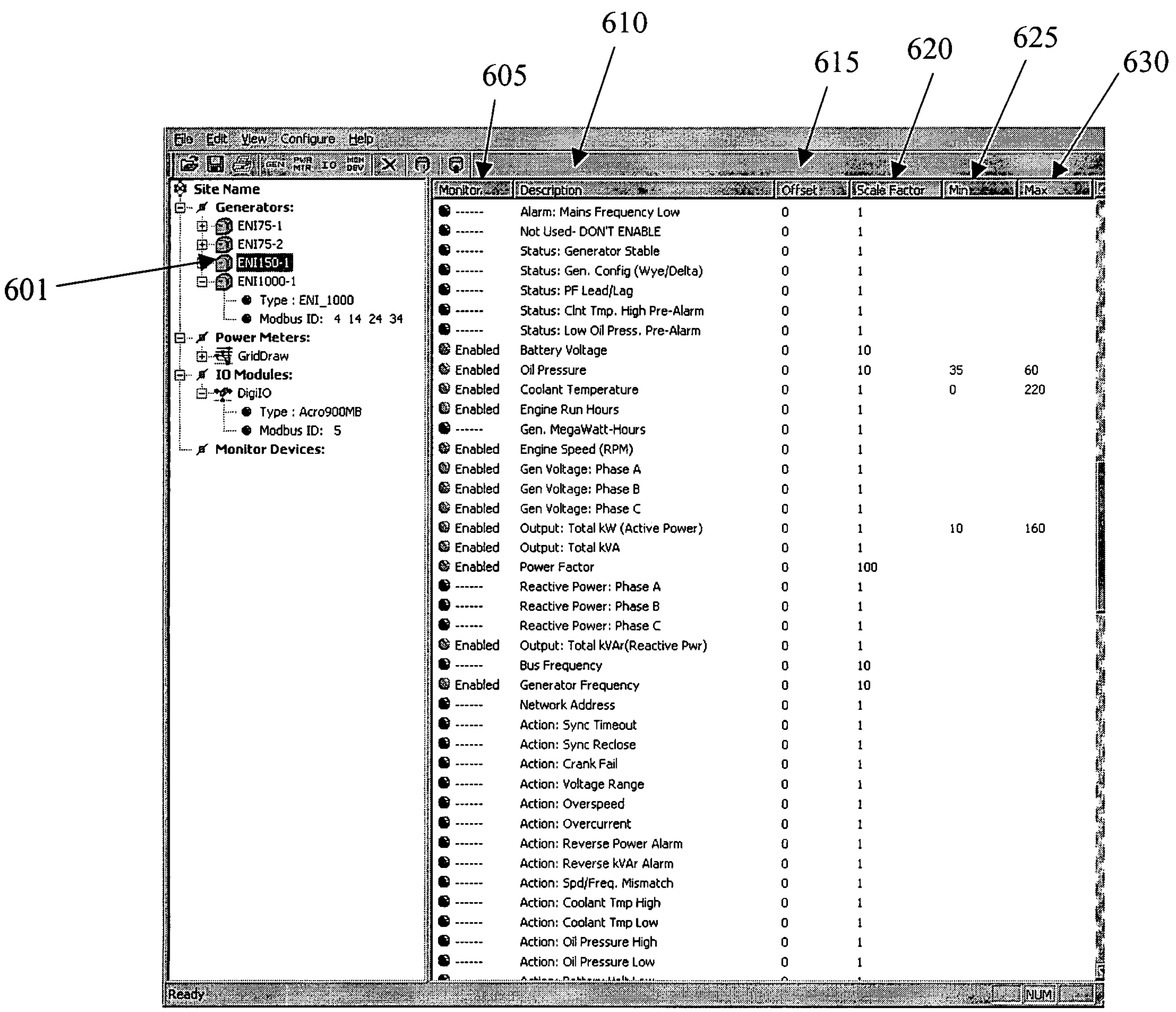
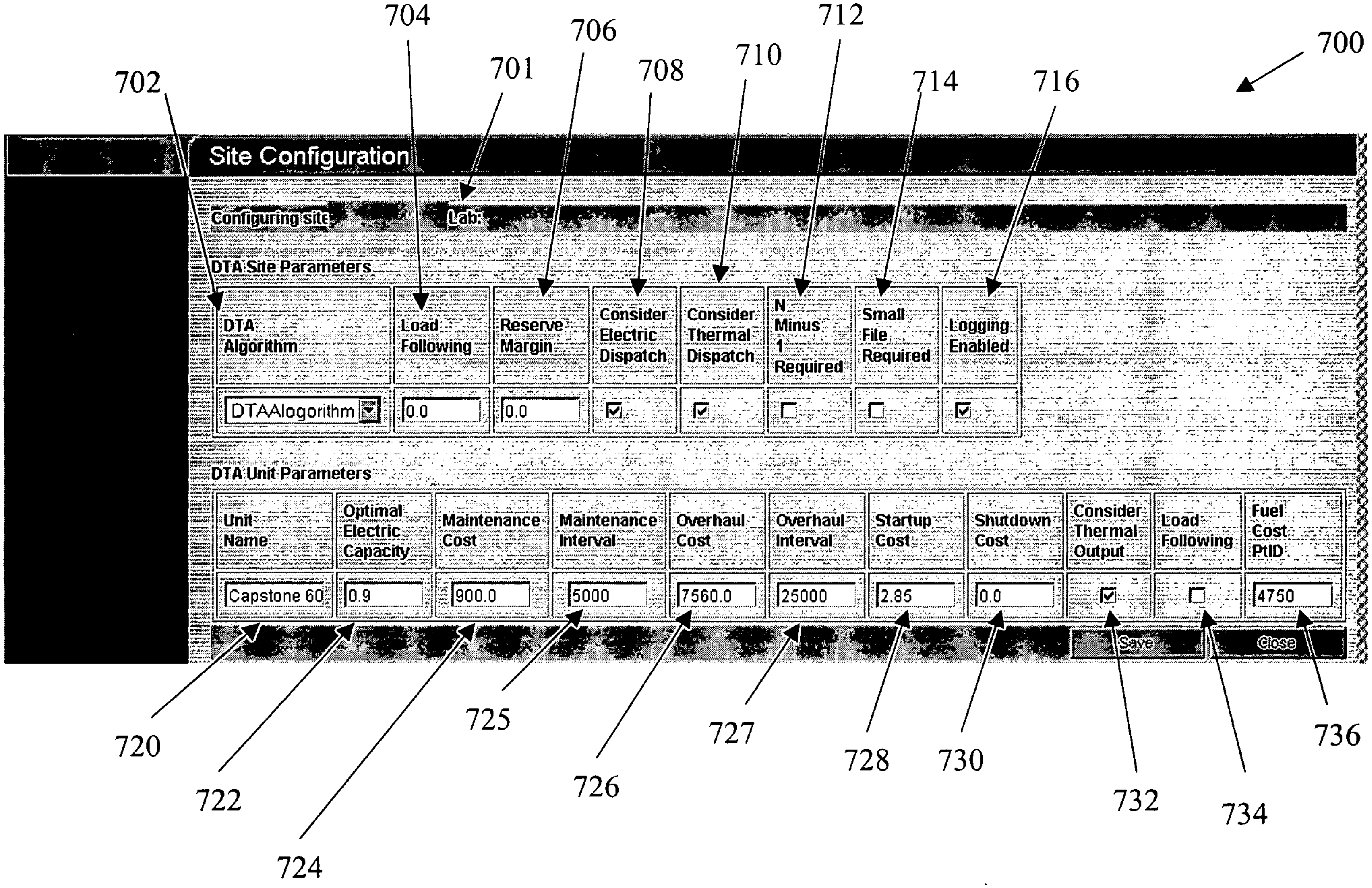


- Site Name
  - Generators:
    - ENI75-1
    - ENI75-2
    - ENI150-1
    - ENI1000-1
      - Type : ENI_1000
      - Modbus ID: 4 14 24 34
  - Power Meters:
    - GridDraw
  - IO Modules:
    - DigiIO
      - Type : Acro900MB
      - Modbus ID: 5
  - Monitor Devices:

| Monitor | Description | Offset | Scale Factor | Min | Max |
|---|---|---|---|---|---|
| ● ------ | Alarm: Mains Frequency Low | 0 | 1 | | |
| ● ------ | Not Used- DON'T ENABLE | 0 | 1 | | |
| ● ------ | Status: Generator Stable | 0 | 1 | | |
| ● ------ | Status: Gen. Config (Wye/Delta) | 0 | 1 | | |
| ● ------ | Status: PF Lead/Lag | 0 | 1 | | |
| ● ------ | Status: Clnt Tmp. High Pre-Alarm | 0 | 1 | | |
| ● ------ | Status: Low Oil Press. Pre-Alarm | 0 | 1 | | |
| ● Enabled | Battery Voltage | 0 | 10 | | |
| ● Enabled | Oil Pressure | 0 | 10 | 35 | 60 |
| ● Enabled | Coolant Temperature | 0 | 1 | 0 | 220 |
| ● Enabled | Engine Run Hours | 0 | 1 | | |
| ● ------ | Gen. MegaWatt-Hours | 0 | 1 | | |
| ● Enabled | Engine Speed (RPM) | 0 | 1 | | |
| ● Enabled | Gen Voltage: Phase A | 0 | 1 | | |
| ● Enabled | Gen Voltage: Phase B | 0 | 1 | | |
| ● Enabled | Gen Voltage: Phase C | 0 | 1 | | |
| ● Enabled | Output: Total kW (Active Power) | 0 | 1 | 10 | 160 |
| ● Enabled | Output: Total kVA | 0 | 1 | | |
| ● Enabled | Power Factor | 0 | 100 | | |
| ● ------ | Reactive Power: Phase A | 0 | 1 | | |
| ● ------ | Reactive Power: Phase B | 0 | 1 | | |
| ● ------ | Reactive Power: Phase C | 0 | 1 | | |
| ● Enabled | Output: Total kVAr(Reactive Pwr) | 0 | 1 | | |
| ● ------ | Bus Frequency | 0 | 10 | | |
| ● Enabled | Generator Frequency | 0 | 10 | | |
| ● ------ | Network Address | 0 | 1 | | |
| ● ------ | Action: Sync Timeout | 0 | 1 | | |
| ● ------ | Action: Sync Reclose | 0 | 1 | | |
| ● ------ | Action: Crank Fail | 0 | 1 | | |
| ● ------ | Action: Voltage Range | 0 | 1 | | |
| ● ------ | Action: Overspeed | 0 | 1 | | |
| ● ------ | Action: Overcurrent | 0 | 1 | | |
| ● ------ | Action: Reverse Power Alarm | 0 | 1 | | |
| ● ------ | Action: Reverse kVAr Alarm | 0 | 1 | | |
| ● ------ | Action: Spd/Freq. Mismatch | 0 | 1 | | |
| ● ------ | Action: Coolant Tmp High | 0 | 1 | | |
| ● ------ | Action: Coolant Tmp Low | 0 | 1 | | |
| ● ------ | Action: Oil Pressure High | 0 | 1 | | |
| ● ------ | Action: Oil Pressure Low | 0 | 1 | | |

FIG. 19

**FIG. 20**



Site Configuration

Configuring site:

Lab:

DTA Site Parameters

| DTA Algorithm | Load Following | Reserve Margin | Consider Electric Dispatch | Consider Thermal Dispatch | N Minus 1 Required | Small File Required | Logging Enabled |
|---|---|---|---|---|---|---|---|
| DTAAlogorithm | 0.0 | 0.0 | ☑ | ☑ | ☐ | ☐ | ☑ |

DTA Unit Parameters

| Unit Name | Optimal Electric Capacity | Maintenance Cost | Maintenance Interval | Overhaul Cost | Overhaul Interval | Startup Cost | Shutdown Cost | Consider Thermal Output | Load Following | Fuel Cost PtID |
|---|---|---|---|---|---|---|---|---|---|---|
| Capstone 60 | 0.9 | 900.0 | 5000 | 7560.0 | 25000 | 2.85 | 0.0 | ☑ | ☐ | 4750 |

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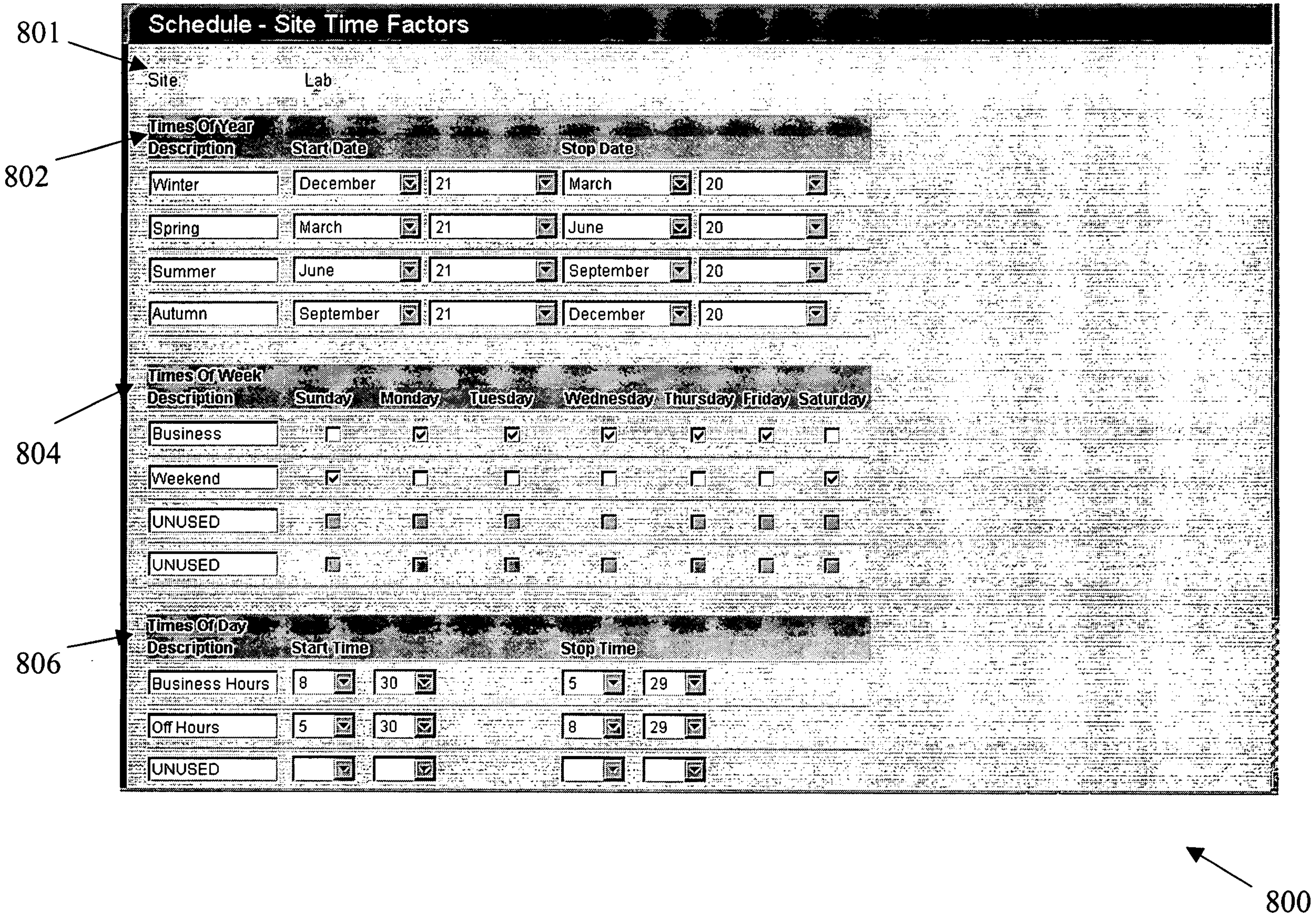
FIG. 21



**Schedule - Site Time Factors**

Site: Lab

**Times Of Year**

| Description | Start Date | | Stop Date | |
|---|---|---|---|---|
| Winter | December | 21 | March | 20 |
| Spring | March | 21 | June | 20 |
| Summer | June | 21 | September | 20 |
| Autumn | September | 21 | December | 20 |

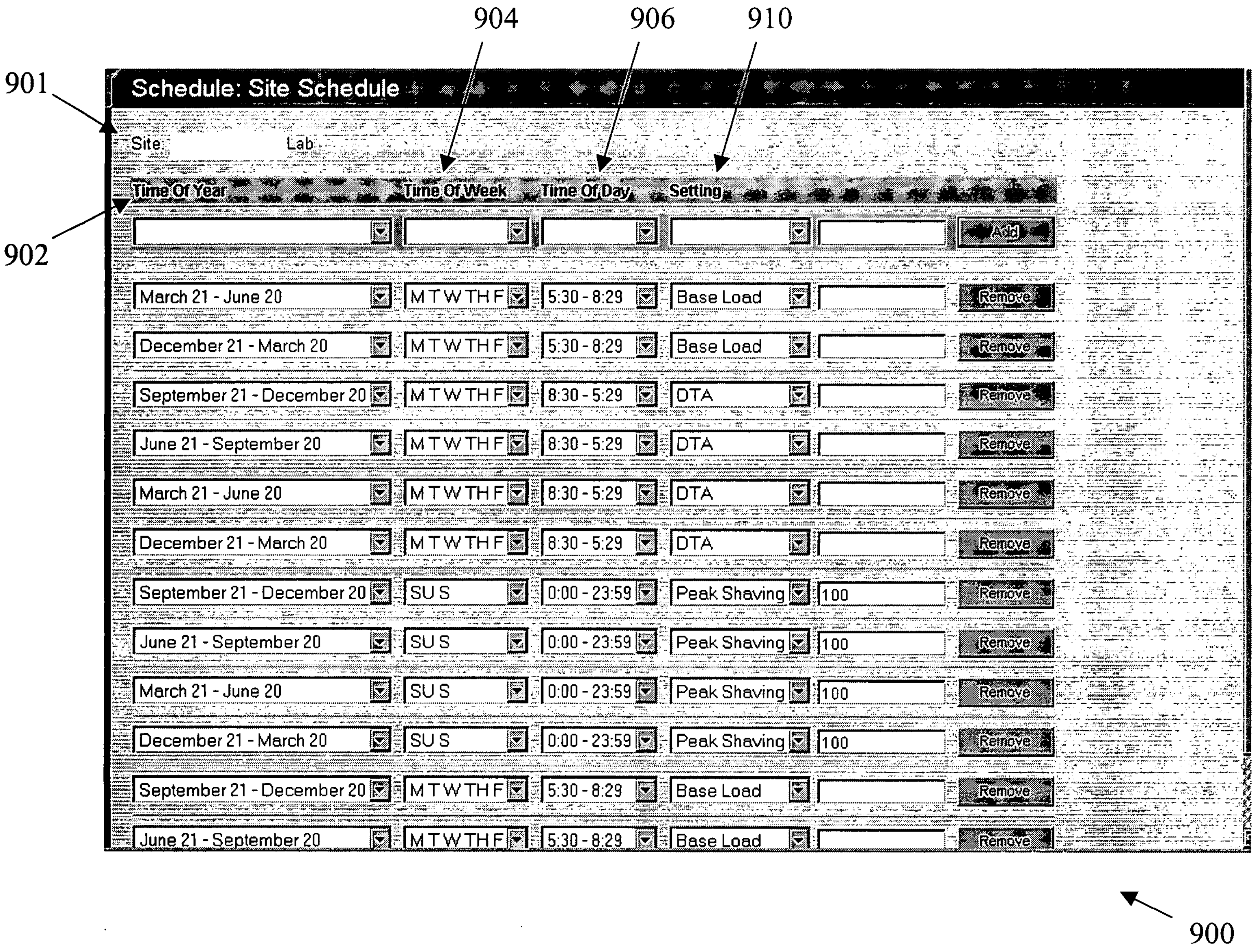
**Times Of Week**

| Description | Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|---|
| Business | ☐ | ☑ | ☑ | ☑ | ☑ | ☑ | ☐ |
| Weekend | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☑ |
| UNUSED | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ |
| UNUSED | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ | ▨ |

**Times Of Day**

| Description | Start Time | | Stop Time | |
|---|---|---|---|---|
| Business Hours | 8 | 30 | 5 | 29 |
| Off Hours | 5 | 30 | 8 | 29 |
| UNUSED | | | | |

**FIG. 22**



Schedule: Site Schedule

Site: Lab

| Time Of Year | Time Of Week | Time Of Day | Setting | | |
|---|---|---|---|---|---|
| | | | | | Add |
| March 21 - June 20 | M T W TH F | 5:30 - 8:29 | Base Load | | Remove |
| December 21 - March 20 | M T W TH F | 5:30 - 8:29 | Base Load | | Remove |
| September 21 - December 20 | M T W TH F | 8:30 - 5:29 | DTA | | Remove |
| June 21 - September 20 | M T W TH F | 8:30 - 5:29 | DTA | | Remove |
| March 21 - June 20 | M T W TH F | 8:30 - 5:29 | DTA | | Remove |
| December 21 - March 20 | M T W TH F | 8:30 - 5:29 | DTA | | Remove |
| September 21 - December 20 | SU S | 0:00 - 23:59 | Peak Shaving | 100 | Remove |
| June 21 - September 20 | SU S | 0:00 - 23:59 | Peak Shaving | 100 | Remove |
| March 21 - June 20 | SU S | 0:00 - 23:59 | Peak Shaving | 100 | Remove |
| December 21 - March 20 | SU S | 0:00 - 23:59 | Peak Shaving | 100 | Remove |
| September 21 - December 20 | M T W TH F | 5:30 - 8:29 | Base Load | | Remove |
| June 21 - September 20 | M T W TH F | 5:30 - 8:29 | Base Load | | Remove |

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